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Stratigraphic Cross Section of Paleozoic Rocks of Nebraska

Russell Smith
University of Nebraska-Lincoln

Raymond Burchett
University of Nebraska-Lincoln

NEBRASKA[1]

(Section C-D, Plate 3)

RUSSELL SMITH[2] AND RAYMOND BURCHETT[3]
Lincoln, Nebraska

INTRODUCTION

The cross section of Paleozoic rocks of Nebraska includes 13 wells and extends from Webster County on the south through Keya Paha County on the north, a direct distance of about 220 mi. Wells are spaced at intervals of 25 mi or less except for wells 12 and 13, which are 37 mi apart. All but well 1 reached the Precambrian and the section is as complete and representative of the broad aspects of Paleozoic geology in the state as present information allows.

Rock descriptions, cross section, and correlations are based on sample studies, drilling-time logs, and electric logs from the files of the Nebraska Geological Survey in Lincoln, Nebraska.

STRATIGRAPHY

Well 1, at the south end of the cross section, penetrated 3,224 ft of Paleozoic strata near the deepest point in the Central Nebraska basin. Total depth is estimated to be 230 ft above the Precambrian. The cross section extends northward and diagonally up the flank of the basin to the state line, where Paleozoic rocks are only 385 ft thick (well 13). There is depositional convergence in most units, but the loss of section is caused chiefly by the erosion of pre-Pennsylvanian beds and of pre-Cretaceous beds on the flanks of the adjacent arches.

Cambrian-Ordovician rocks consist mainly of the Arbuckle Group. These strata lie on the basement surface in wells 2 and 4 but are underlain elsewhere by 10–30 ft of basal "Reagan" Sandstone. The Arbuckle consists mainly of dolomite which thins from 230 ft in Webster County (well 1) to a featheredge in southwestern Holt County, where it is overlapped by Simpson rocks (well 10). The dolomite is gray to brown and crystalline with zones of sandy dolomite and abundant glauconite. Samples show streaks of intercrystalline porosity, but the only show of oil was about 15 ft below the top of the Arbuckle in well 3.

Two layers of red and green shale separated by a layer of sandy dolomite comprise the Simpson Group in most wells. There is a gradual increase in sand toward the north. The group is 80–140 ft thick except at the north end of the section where it pinches out beneath the Viola Formation.

The Viola Formation is uniform lithologically, but nonuniform in thickness. It is 300 ft thick in Adams County, thins northward and is absent in Valley County, is about 30 ft thick across Garfield, Holt, and Rock Counties, and thickens to 70 ft in Keya Paha County. The unit is buff to tan, dense to finely crystalline dolomite. Chert is common. Samples show many porous zones but only wells 3 and 5 had stains of oil.

The Maquoketa Group is a limestone unit 90 ft thick in Webster County (well 1); it thins gradually to a featheredge in northwestern Howard County. Except for an absence of chert, the Maquoketa is similar to the Viola and the two are differentiated best on the basis of electric-log characteristics.

Silurian, Devonian, and Mississippian strata have an aggregate thickness of 340 ft in Webster County, but all are truncated by the Cherokee Shale in Adams County. The rocks consist chiefly of tan to brown limestone and dolomitic limestone with scattered cherty and oölitic layers. They are present in eastern Nebraska, but only a wedge of Devonian dolomitic limestone in Howard County (well 5) and another wedge of Mississippian oölitic limestone in Rock County (well 12) escaped pre-Cherokee erosion along the line of the cross section north of Adams County.

The South Dakota Geological Survey does not believe now that the Mississippian limestone is truncated north of well 12. On the basis of recent, unpublished work, they consider the dolomite in the bottom of well 13, here shown as Viola (Ordovician), to be of Mississippian age and equivalent to the Lodgepole Formation in the Williston basin (Schoon, personal commun.).

The Pennsylvanian System includes the Cherokee and Marmaton Groups of Des Moines age, the Lansing-Kansas City Group of Missouri age, and the Douglas, Shawnee, and Wabaunsee Groups of Virgil age. The aggregate thickness of these beds is 1,200 ft in Webster County and 800 ft in Valley County; northward thin-

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[2] University of Nebraska.

[3] Nebraska Conservation and Survey Division.

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ning is relatively uniform in all units. North of Valley County the strata are truncated in descending order by the sub-Cretaceous unconformity, and only 300 ft of Des Moines beds remains in Keya Paha County.

The Cherokee shale consists of red, green, and black shale and sandstone; there is a marked increase in sandstone content toward the north. Marmaton, Lansing-Kansas City, Douglas, Shawnee, and Wabaunsee beds are principally dense limestone with interbedded shale and some sandstone. Sandstone layers are most common from Howard to Garfield Counties; many of the limestone beds are oölitic in the same area. An oölitic zone near the top of the Lansing-Kansas City Group had a show of oil in Sherman County (well 6).

Truncation of Permian rocks reduced them from a thickness of 1,200 ft at the Kansas line to a featheredge in Garfield County. The Admire, Council Grove, and Chase Groups consist of red and green shale interbedded with brown, dense limestone in approximately equal proportions. Four sandstone beds were drilled in Adams County (well 3), but elsewhere sandstone is rare to absent. Most Council Grove and Chase limestone beds are dolomitic.

Red and gray shale and anhydrite of the Sumner Group overlie the Chase in well 1. These beds, which are 340 ft thick, are the youngest Paleozoic rocks along the line of the cross section.

STRUCTURE

The Central Nebraska basin is the northern extension of the Salina basin of Kansas. It is bounded on the north by the Siouxana arch, on the southeast by the Nemaha arch, and on the west by the Cambridge arch. The Siouxana arch is not shown on the index map because it is in South Dakota. Regional dip in the eastern part of the basin is southwest at about 14 ft per mile.

Subsurface data collected in and adjacent to the area of the cross section show several anomalous areas which appear to be caused by a series of south- to southwest-plunging noses. Contours on the pre-Pennsylvanian erosional surface show five such features (Carlson, 1963, Pl. I)—one in northeast Loup County, a second in southwest Garfield County, a third in Greeley and Sherman Counties, a fourth in Howard County, and a fifth in Adams County. Precambrian elevations, although less numerous, suggest the presence of a similar structural pattern except in Adams County, where regional southwest dip prevails on the basement surface (Carlson, 1961).

Partial evidence for the noses is shown on the cross section. The one in Garfield County is indicated by wells 8 and 9, which show north dips of 6 ft per mile on both the pre-Pennsylvanian and Precambrian surfaces. The cross section does not reflect the structure in Greeley and Sherman Counties, but a well 10 mi north of number 6 is 73 ft lower on the Precambrian and another well 10 mi east is 211 ft lower. The Adams County nose probably is formed by a buried escarpment where the eroded edges of Mississippian, Devonian, and Silurian limestone trend northeast between wells 2 and 3.

The other two anomalies are less clear. That in Howard County may be caused by the wedge of uneroded Devonian limestone noted in well 5. Published maps (Carlson, 1961, 1963) indicate that the Loup and Garfield features lie on a single nose which plunges about S. 10° W. However, information gained from recent drilling in Loup County supports the concept of two separate noses plunging southwestward.

Data from the vicinity of the cross section as well as known conditions elsewhere in the state suggest that the structural features described are probably the result of paleotopographic relief rather than tectonic deformation.

GEOLOGIC HISTORY

Regional subsidence and transgression of the sea onto the Siouxana arch in Cambrian and Early Ordovician times are shown by the northward increase in terrigenous clastic material in pre-Simpson rocks. Abrupt thinning of the Arbuckle dolomite between wells 6 and 7 and the presence of sandstone in the basal Simpson strata indicate retreat of the sea and erosion at least as far south as Sherman County prior to Middle Ordovician time. Similar beveling of Lower Ordovician beds in Fillmore County on the east and in Buffalo County on the west indicates the first emergence along the Nemaha and Cambridge arches at that time (Reed, 1954, p. 113).

Deposition resumed during the Champlainian Epoch and appears to have been continuous on the south and east until the end of the Mississippian Period. However, the presence of Devonian on Maquoketa in Howard County (well 5) and of Mississippian on Viola in Rock County (well 12) indicates uplift on the north in pre-Devonian and in pre-Mississippian times.

The regional unconformity at the base of the Pennsylvanian System is present throughout Nebraska as well as in most of the Mid-Continent. Maximum uplift along the line of the cross section took place in Valley County, where Simpson beds were exposed by the subsequent erosion (well 7). Marked thinning of the Cherokee Shale there also suggests that the area remained emergent after Pennsylvanian deposition had begun elsewhere.

Post-Cherokee Paleozoic history was characterized by widespread and apparently continuous subsidence. Reed (1954, p. 114) refers to a possible rejuvenation of the

Siouxana arch at the end of the Pennsylvanian Period, but states that present evidence is inconclusive. The era ended with re-uplift and stripping of Permian rocks as far south as Garfield County and erosion down to Des Moines beds in Keya Paha County.

OIL AND GAS

The only production in the Central Nebraska basin is from five small pools in Harlan County which had yielded a combined total of 342,500 bbl of oil as of January 1965 (according to records of the Nebraska Geological Survey). The reservoir rock is the limestone in the Lansing-Kansas City and trapping is where oöcastic zones are present over minor structural features.

The number of wells in the 10 counties traversed by the cross section ranges from two dry holes in Keya Paha County to 10 in Webster County. Similarly inadequate testing is characteristic of most of the basin area. The Lansing-Kansas City beds and the "basal Pennsylvanian sand" now are believed to be the best prospects for future discoveries. Truncation and overlap at any of the unconformities also may provide possibilities for hydrocarbon accumulation.

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